THE IMPACT OF VARIOUS INSTRUCTIONAL STRATEGIES ON STUDENT ENGAGEMENT WITH MATHEMATICS

by
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ABSTRACT
SIDNEY SCOTT: The Impact Of Various Instructional Strategies On Student Engagement With Mathematics

The purpose of this research is to investigate the variation of student engagement with mathematics depending on the instructional method implemented in a secondary classroom. I looked into the strategies of lecture, group sessions, and direct instruction. In order to compare the student engagement among the methods, I developed a checklist instrument to verify when students were engaged based on seven indicators of engagement – teacher-led questions, student-led questions, showing work on the board, group work, growth between formative assessments, nonverbal engagement, and the use of differentiation. My findings show that the group sessions scored higher on the engagement indicator checklist than both the lecture and direct instruction. As engagement with mathematics plays a pivotal role in success in a mathematics course, I expect my research to enrich my experience as a young teacher and allow me to better serve and educate my future students.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

As a classroom observer, student teacher, and future educator, I am interested in the wellbeing and academic success of my students. Beginning with my time as an observer in a middle school mathematics class, I observed that some students were more involved with the lesson or the presented task than others. I started taking note of when students were participating and when they appeared distracted or bored and tried to make connections between the classroom's dynamic and the students' resulting behavior. Once I started student teaching in a high school Algebra III class, I was able to begin formalizing this idea of participating with the mathematics as student engagement. It is my belief that engagement can be seen as both classroom participation, or as growth shown by the students regarding the concept covered in the lesson. As part of my current credential program, I am required to write self-reflections of my teaching on a regular basis. Throughout my reflections, I have found that student engagement with mathematics seems to vary based on the instructional method I use to teach. Thus I have been able to further explore how student engagement can be identified and under what circumstances it flourishes. I also realize that some tasks are more engaging than others. As I made my observations, I made sure that tasks were sufficiently engaging and challenging, as appropriate for the mode of instruction. That way, I could focus primarily on the effects instructional methods have on student engagement.

As a young teacher, I want to provide the best opportunity to meet my students' educational needs and promote academic achievement, and I believe that stems from

greater student engagement with mathematics. This conjecture has led me to ask, how can I easily observe and make note of students who are engaged with the material? And, do some instructional strategies promote student engagement on a deeper level than others?

LITERARY REVIEW

A quick search through educators' blogs and academic articles will yield countless results for creating a classroom that promotes student engagement. Each author will provide examples of engagement strategies, and he or she may even include something along the lines of a four-step approach to achieving engaged and interested students (Provenzano, 2016, p. 1). Some suggestions include talking about student interests at the beginning of class and utilizing project-based learning (Provenzano, 2016, p. 1), allowing students to teach the lesson (Allison, 2017, p. 1), and seeking feedback from students (Baron, 2015, p. 1). Student engagement and how to establish it in today's classroom is at the forefront of many educators' minds and is a topic worth pursuing

What is engagement?

So what is engagement exactly? While important, it is not an easily defined construct (Marzano and Pickering, 2011, p. 3), and there is no single correct definition of the term (Skinner et al., 2009, p. 224). According to Marks (2016), it encompasses "attention, interest, investment, and effort students expend in the work of learning" (p. 16). Put simply, it is "students' involvement with school" (Finn, 2016, p. 1). While many definitions will reference motivation and interest as major components of engagement (Skinner et al., 2009, p. 224), I will be exploring both active and non-active engagement. Based on my perception of engagement, active engagement refers to students verbally participating with their peers or physically working on a particular mathematical task.

Non-active engagement refers to students showing nonverbal indicators of engagement, which will be expounded upon later. They might also show no outward signs of engagement, yet show growth based on formative assessments – which is proof that they were engaged at some point during the instruction, despite appearing unengaged.

Why is engagement important?

Researchers have linked engagement to higher academic success and higher efficacy in the course (Kotecha, 2017, p. 6). Based on my observations, when there is little engagement in the classroom, there is a gap between the teacher and the students, where conversations are usually short-lived and feedback is minimal. This leads me to ask the question, what methods promote engagement in the classroom, creating a learning environment that benefits all students (Goss and Sonneman, 2017, p. 6)?

The importance of feedback

As a classroom observer, I was tasked with looking for student engagement in a 7th grade math class to which I had been assigned. One of the issues I noticed was if students did not get help promptly after raising their hand, they would put it back down, and their question would never be answered. The students who did not receive the answer to their question or were not called on to give their input in discussion, appeared to lose interest and became less actively involved. This observation prompts the question, how relevant is immediate, or timely, feedback to student engagement? According to a study conducted in Chile on increasing student engagement in math using Khan Academy, "the immediate feedback feature and access to just-in-time assistance" was the largest

contributor to keeping students engaged with math (Light, Pierson, 2014, p. 18). The article mentioned how, with this feature, they did not have to wait for teacher's assistance and could instead get help from peers or from the Khan platform (Light, Pierson, 2014, p. 19). The instant feedback and assistance keep students from getting distracted or discouraged while waiting for the teacher to finish assisting another student, which increases their time engaged in the activity. From this research, we can see the importance of timely feedback, but how can a teacher promote that in a classroom where the student to teacher ratio makes it seem nearly impossible? He or she could certainly utilize Khan Academy, but even then the students would be receiving "one-size-fits-all" feedback, as opposed to personalized feedback. Just as a teacher cannot be everywhere at once, a teacher cannot give personalized feedback to everyone in the timeframe it would take to keep each student engaged. This is the reason there is not much feedback or monitoring embedded in a lecture-based classroom, calling into question the use of the classroom structure.

Purposeful Grouping

The research conducted by Daniel Schaben in "Improving Student Engagement and Verbal Behavior Through Cooperative Learning" provides an insight to the problem mentioned above. The article states that the implementation of purposeful groups in the classroom creates a support network for students to turn to someone other than the instructor (Schaben, 2016, p. 1). This network would serve as a student's source of immediate, personalized feedback, allowing students to struggle with their peers to find solutions instead of simply getting an answer from the teacher. I believe that this struggle,

in turn, promotes learning in the place of rote memorization, and it fosters greater engagement. Vygotsky is famous for his theories on how children develop knowledge through social interaction. He describes learning as a social process, and states that interacting with others furthers student development (Vygotsky, 1978, p. 57). Gillies expounds on Vygotsky's theory, "When children work cooperatively together, the group creates a zone of proximal development (ZPD) enabling members to be successful at tasks that would be unable to do alone" (Gillies, 2017, p. 39). A diagram illustrating the positive impact of Vygotsky's theory and the expanding ZPD is given in Figure 1, where the group's ZPD is the sum total of Student A, Student B, and Student C's ZPD.

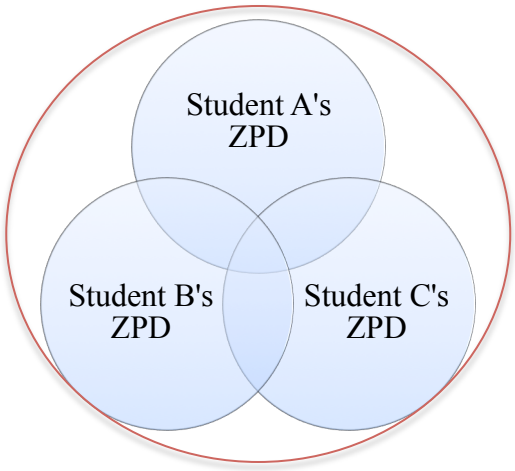

Figure 1

The cooperative aspect of learning is highlighted in the Common Core Standards for Mathematical Practice. In the third mathematical practice (MP3), it states that students should be able to communicate with and critique the reasoning of others (*Standards for Mathematical Practice,* 2018, p. 1).

Using purposeful groups would also help avoid the problem of students picking up incorrect methods or shortcuts and believing their process is correct. Just because a student gets a correct answer, does not mean he or she knows the material. And their fallacy has the potential to become the base of their learning and carry them through the rest of their schooling if it is not addressed. In a lecture-based class, there is no feedback or monitoring of every single step. I have observed that in small groups, however, peers are more likely to notice errors in thinking and address them in a timely matter.

How can a teacher promote a collaborative style of learning from peers in a classroom where students are used to depending on the instructor? From my observation in the classroom, students would often raise their hand during group work and call the teacher over to discuss questions instead of struggling with it amongst themselves. The teacher, however, would require them to talk to each other while monitoring their discussion, only jumping in if necessary. This method will help students learn to rely on each other in the future. The teacher would also make sure that each member of the group was cooperating with the others by rewarding the students who participated. For example, she would instruct the groups to discuss amongst themselves to formulate an answer to a problem. While some students discussed with their groups, others worked independently and raised their hand to answer. The teacher specifically did not call on the students who worked independently in order to support collaboration and teach the students to work with each other. Essentially the teacher was establishing and enforcing groups norms.

In using cooperative groups, the teacher's role shifts from "sole provider of instruction" to "manager of setting up collaborative experiences." The instructor would also monitor and, in some cases, restructure the groups he or she formed. In order to

achieve engagement in cooperative groups, they must be structured in such a way as to foster the best learning outcome for all members. Critics of cooperative groups claim that all too often students will sit back and let the others do the work, or simply mimic the opinions of others and lose sight of their own ideas in succumbing to peer pressure (Cain, 2012, p. 1). However, research shows that when groups are structured purposefully and students are held accountable for their own learning, this is not the case. According to Hattie, Fisher, and Fray (2017), accountability prevents one student from completing the task for the other members of the group (p. 154).

It is often cited that groups should be composed of three to four members, be gender-balanced, and be of mixed ability (Gilles, 2017, p. 47). During my observation, however, I have noticed where this structure is not the only one that is effective. While reviewing for a test, the teacher I observe organized her students into ability homogeneous groups. The students were placed with other students who needed help in similar areas, so they were able to support each other and the teacher was able to better instruct them according to their specific needs. This specific case would require tight monitoring on the part of the teacher in order to keep students from falling behind or adopting common misconceptions. I also do not suggest that homogeneous groups be used on a regular basis. "Meeting with a small group of students for some needs-based, teacher-guided instructed is valuable. But permanently tracking students contributes to a destructive and fixed mindset…" (Hattie, et al., 2017, p. 155). According to *Visible Learning for Mathematics*, "The most effective grouping strategy is one that is flexible and balances, and that allows for moderate but not extreme range of skill level" (Hattie, et al., 2017, p. 155). This structure "should not be fixed, rigid, or permanent," but should

instead “allow for more robust and responsive differentiation of instruction” (Hattie, et al., 2017, p. 155). It is important that the structure of the group matches the desired outcome or goal of the activity. According to Guillaume (2016), ability grouping should be based on “assessment of specific performance related to the content rather than perceived student ability,” it should be flexible, and it should provide students the opportunity to work with a variety of peers over time (p. 64). One important key factor in grouping effectively is that the groups are based on the most recent and timely assessment for an accurate interpretation of their ability on a particular concept (Hattie, et al., 2017, p. 155). An instructor can use current formative assessment data to make in-the-moment decisions about grouping – should certain groups be restructured? Should some students be sent to other groups to discuss their ideas? Is there one group that needs more support than the rest? Groups that are assigned at random will not produce the kind of engagement that is desired – there should always be a purpose behind the group structure.

Group Norms

Grouping alone does not cause engagement; norms and goals play a pivotal role (Guillaume, 2016, p. 65). It appears that an important aspect of group work is that the students are instructed in the collaborative skills required – either directly through instruction, or indirectly through teacher modeling – and are held to that standard (Gilles and Boyle, 2017, p. 936). Often, before the teacher I observed broke her students into groups, she asked the class what working together looks like and listed some expectations of group work. The expectation that students were responsible for their own work and

should not simply be receiving answers from their group kept students engaged in their work. Essentially the teacher was establishing and enforcing groups norms. When given clear instructions and expectations, the students worked well together, even when the teacher did give each student a role in the structure of their group. “Savvy teachers know that they need to revisit collaborative skills and routines throughout the year” (Hattie, et al., 2017, p. 159). An example of norms given created by students in my Algebra III classroom are outlined in Figure 2.

Figure 2

Granted, just because group norms are set does not necessarily mean that students are always following them. An instructor should closely monitor the groups to make sure that they are functioning correctly and decide if and when it is appropriate to intercede.

Formative Assessments

As manager of collaborative experiences, the teacher is still expected to monitor the groups and give and receive feedback to check for understanding (also known as using formative assessment). Formative assessment is “the process of gathering evidence

to inform instruction" (Hattie, et al., 2017, p. 200). Some of its key elements include clarifying criteria for success, engineering discussion, providing feedback that moves learning forward, and activating learners as both instructional resources for one another and as owners of their own learning (Hattie, et al., 2017, p. 210). Formative assessments can take many forms, such as thumbs up/thumbs down, response sticks, classroom response systems, or other digital tools (Kersaint, 2015, p. 1), as well as simply walking around the room and taking note of student progress.

Two important forms of formative assessment are openers and closers (also known as bell ringers and exit tickets respectively). It is important to begin engaging students with mathematics as soon as possible, and openers are a perfect way to ease students into thinking about the skills and information they will need later on the lesson, or to get ideas on the table concerning a new topic. Teachers can use pre-assessments (or openers) to "identify baselines in understanding and performances" (Hattie, et al., 2017, p. 40). They can be used to activate prior knowledge, which should help prepare students for the acquisition of new knowledge (Hattie, et al., 2017, p. 44). They are useful formative assessment tools to provide a direction for the course of the lesson. Openers can also be used as timely data to form purposeful groups or to reform groups if necessary, setting up the class for success. Closers can be used to tie the lesson together, and they also serve as feedback for the students to let them know if they have met the goal for the day. Since they highlight the students that need additional practice, closers are useful for assessing student needs and adapting the instruction for the next day based on the results (Hattie, et al., 2017, p. 202). Not to mention, it keeps students engaged with

the math all the way to the end of class (as opposed to them packing up and standing by the door).

Differentiation

Formative assessments can be useful tools to support differentiation in the classroom. Tomlinson defines differentiation as, "the consistent use of a variety of instructional approaches to modify content… in response to the learning readiness and interests of academically diverse students" (Tomlinson, 1995, p. 80). Instructors can use pre-assessment results to judge the level of understanding a student holds on the concept. Once their current level is identified, differentiation can provide students a level of academic expertise out of their range through creating a supportive group environment, asking questions, or presenting problems suited for their current ability. This idea harks back to Vygotsky's Zone of Proximal Development - appropriate tasks are necessary to keep students engaged at the right level. "Differentiation of instruction is about making sure all students are working within their own zone of proximal development" (Hattie, et al., 2017, p. 212). If the task is too hard and the students cannot enter it, they will likely become unengaged; if it is too easy, they will finish quickly and become unengaged. The problem has to be at the right level for each student - which is why differentiation plays a major role in student engagement with mathematics. As stated by Sousa and Tomlinson (2018), "In a differentiated classroom, flexible grouping is non negotiable" (p. 180). Thus, differentiation supports the use of dynamic groups centered on the goal of the lesson.

Class discussion

Formative assessment methods not only aid in differentiation, but they also serve as a gateway into group and class discussions. The teacher has to anticipate what students might say and then structure the lesson to orchestrate discussion. This is yet another facet of how the teacher is to manage collaborative experiences. Meaningful discussion is not likely to happen on its own. Based on student responses, the teacher can take the opportunity to talk about mistakes. This step is critical, because students must confront misconceptions in order to get past them. It is important for students to "understand they learn and develop understanding from making mistakes" (Hattie, et al., 2017, p. 17). The teacher I observed implemented this practice by showing the overall class results from an assigned problem and asking students to explain how they arrived at a particular answer and why they believe it is correct.

Confronting mistakes and involving students in discussion can be intimidating, especially for shy or introverted students. That is why it is important for teachers to create a safe environment to bring up their ideas. Collaborative groups help minimize intimidation by giving these students a smaller circle with which they may be more comfortable sharing their ideas. Structuring the groups so that these particularly shy students are among others with shared interests can also help keep them more engaged instead of being withdrawn (Cutler, 2016, p. 1). Instructor should ensure every student has a voice or contribution to the classroom discussion, and that every student has an outlet with which they are comfortable expressing that voice. Groups can help give shy students a voice by allowing them to share within their group. Their group can then contribute to classroom discussion on that student's behalf. This method ensures that the

student's ideas are heard without the added intimidation of speaking in front of the whole class. The same can be applied to the use of personal whiteboards in cooperative groups. Technology can also give voice to everyone through its potential anonymous features. For example, when Plickers or Desmos results are shown, they can be set to anonymous so that each student's thoughts are available to the class without the individuals being singled out specifically. This shared workspace also provides feedback and fosters discussion, which both stimulate student engagement.

Impact on academic success

Student engagement also has positive impacts on academic success and higher efficacy in the course (Kotecha, 2017, p. 6). According to Finn and Rock, if students are engaged in their schoolwork, they are more likely to perform well academically, which includes getting higher grades in their classes and on standardized tests (qdt. in Bundick, et al., 2014, p. 116). Therefore, students perform better when they are engaged versus when they are not, and better engagement directly corresponds to better achievement and higher grades. As a young teacher, I am interested in the wellbeing and educational achievements of my students. Thus, promoting engagement should be a top priority of mine.

Instructional Methods

Student engagement is an important aspect in creating a successful learning environment for all students, and it should be incorporated into the classroom. A question that my observations have led me to ask is, "Do some instructional strategies promote

engagement more than others?" As some tasks are more engaging than others depending on student interest, I made sure that tasks were sufficiently engaging and challenging, as appropriate for each mode of instruction I was observing. Exploring engagement within the context of different methods of teaching, namely using lectures, direct instruction, or groups, can help me conclude what conditions yield the greatest opportunity for engagement.

Lecturing is an instructional method where the teacher holds all control. Based on my experience, there is minimal input from students and it is comprised mostly of the teacher teaching "at" the students without allowing them to work with the material and make discoveries on their own. Students are not allowed a lot of input as far as the direction of the conversation of the class is concerned. The instructor is the one who determines the course of the thinking in the classroom and decides which ideas are validated and which are not. This method leads to many students simply regurgitating memorized answers as opposed to truly engaging with and learning from the mathematics. While lecturing is often a go-to method for many teachers and college professors, it seems to do a poor job of keeping students engaged in the lesson (Hattie, et al., 2017, p. 24).

Lecture and direct instruction are two vastly different approaches to teaching, though many may wrongly label a lecture as direct instruction (Hattie, et al., 2017, p. 3). In direct instruction, "the teacher decides the learning intentions and success criteria, makes them transparent to the students, demonstrates by modeling, evaluates if they understand what they have been told by checking for understanding, and re-tells them what they have been told by tying it all together with closure" (Hattie, 2009, p. 206).

Direct instruction involves a more scaffolded and intentionally guided process when compared to a lecture (Hattie, et al., 2017, p. 116). In direct instruction, students are encouraged to participate in discussion, talk and work in groups, and contribute their thoughts to the lesson. They can put ideas on the table and then others can bounce off of those ideas - without a lot of teacher interference. The instructor may present a task for the students to complete that builds on what they previously discussed. While in a lecture some students may provide a few thoughts, the direction of the lesson is fully at the mercy of the instructor. Direct instruction is one method a teacher can use to teach mathematics, though it should only be used when appropriately based on the mathematical and learning goals of the lesson.

Direct instruction can be useful in fostering classroom discussion, where students are expected to explain and defend their reasoning (Hattie, et al., 2017, p. 25). A teacher may be conducting what appears to be a "good discussion" only to find that the same students are the ones sharing over and over again. So what happens when not enough students are taking part in the discourse? How can an instructor encourage more students to participate and put their ideas on the table? Or what if the teacher takes over the discussion? "Too often, whole group classroom discussion quickly slides back into a lecture, with the teacher occasionally posing a question and allowing a few students to respond before once again returning to his or her monologue" (Hattie, et al., 2017, p. 165). To help address some of the aforementioned questions, an instructor can begin with small group collaborative learning, and then bring the class together for whole class discourse (Hattie, et al., 2017, p. 151). If groups are functioning correctly, the students

should be talking to each other – defending their thinking and discussing how they think a problem should be solved.

Research suggests that purposeful groups can serve to create a support network for students where they are able to learn from peers and receive individualized, relevant feedback (Light, Pierson, 2014, p. 18). Dynamic groups should be formed using timely formative assessments, and they should be restructured as need arises (Hattie, et al., 2017, p. 155). The instructor's use of differentiation, enforcing group norms, and monitoring enrich the students' cooperative experience during group work (Sousa and Tomlinson, 2018, p. 180; Gilles and Boyle, 2009, p. 936). Groups can also provide a safe environment for students to address misconceptions and be involved in discussion (Hattie, et al., 2017, p. 17). When observing and implementing these methods in the classroom, the students appear to be more engaged with the material being presented.

EXPERIMENTAL DESIGN

In the early stages of my exploration, I decided to find a way to tell which of my students were engaged and which were not. I had to formalize what engagement was and then come up with a set of indicators that proved when students met that definition, as opposed to finding another resources' indicator. I started by using a simple checklist where I put a checkmark by a student's name if he or she asked or answered a question. But that method did not account for instructional strategies that include more than only teacher-to-student interactions. It also did not include any indicators, other than talking, as engagement. So to help develop a more in-depth look at engagement indicators, I had to think about both the Common Core Standards for Mathematical Practice as well as common classroom occurrences that lead to engagement with the mathematics.

Common Core Standards for Mathematical Practice

What evidence do instructors have to show that the students are actually engaged in a mathematics classroom? In a common core mathematics class, a useful indicator of engagement with the material would be if a student were enacting the Standards for Mathematical Practice (*Standards for Mathematical Practice*, 2018, p. 1). The Standards for Mathematical Practice are something that students must experience and do as they develop as budding mathematicians (Hattie, et al., 2017, p. 118). The eight vital practices include: Make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model

with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure, and look for and express regularity in repeated reasoning. I will be focusing on the first and third mathematical practices (MP) for the purpose of exploring student engagement; however a description of all eight practices is given in Figure 3 in the appendix.

In the first Mathematical Practice (MP1), mathematically proficient students are students who approach a problem "by explaining to themselves the meaning of a problem and looking for entry points to its solution" (p. 1). They also analyze what is given to them in the problem, as well as possible constraints, relationships, and goals. They evaluate their progress and change their approach or method if needed. They then check their answers and make sure it makes sense. This practice relates to engagement in that a student who is actively making sense of a problem and persevering in solving it is engaging with the mathematics.

According to the third Mathematical Practice (MP3) from the *Standards for Mathematical Practice*, "Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures" (pg. 1). These students are able to justify their conclusions, as well as communicate and defend their findings. They are also able to distinguish correct and flawed reasoning or logic, and able to explain any flaws they found. Students can also "listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments" (pg. 1). Essentially, this practice is all about being able to communicate the math that is occurring in the classroom and make a case for particular methods or solutions. If a student is effectively communicating the math, then they are engaged.

Development of Indicators

Working in conjunction with *The Standards for Mathematical Practice*, I have developed a progression of classroom occurrences to help me create a checklist of indicators an observer can use to verify whether or not a student is engaged. To develop the progression, I observed and listed a variety of scenarios that occurred in an Algebra III classroom where I am a student teacher. I then made note of the steps it would take for that scenario to arrive at student engagement. The classroom occurrences consist of teacher-led questions, student-led questions, a student showing his or her work on the board, non-verbal attentiveness, showing growth on formative assessments, students working in groups, and the use of differentiation to keep students engaged.

Teacher-Led Questions

Teachers often present students with opportunities to answer questions throughout a lesson, thus giving them a chance to be engaged. An interesting occurrence, though, is when the majority of the class answers in a choral response. In that particular case, the first student is likely engaged in the discourse, but there is not evidence to suggest that everyone else who responded is engaged – some students may simply be following the majority. If a teacher presents a question and asks the students to think about it, but not respond, then there is no outward evidence of student engagement. The same applies for a situation in which a teacher asks if the class understands, and the students nod or simply reply with “yes” or “no” – some students may be engaged, but it is not easily observable. If a teacher asks a question and students reply individually on their personal whiteboards after an adequate wait time, then their answers on the whiteboards can serve as evidence

of their engagement with the material. Another common classroom occurrence that often arises is a teacher posing a question and asking the students to discuss their responses amongst themselves. When that occurs, students would be considered engaged with the mathematics as long as their conversations remain on-topic, which would require monitoring on the part of the instructor.

Student-Led Questions

Along with teacher-posed questions, questions initiated by students carry the potential for engagement. For instance, if a student presents a question to the teacher related to the topic at hand, then he or she is showing evidence of their engagement with the mathematics. After that occurrence takes place, another student may ask either the teacher or the first student a follow-up question – expanding the number of students engaged due to the initial question. Engagement would further continue if the first student responds to the second, and that student is able to show that he or she learned from the first, either by completing a problem on their own or by discussing the answer with a third student (which would prove that he or she was actually engaged twice). This pattern could continue, increasing the number of students who are engaged.

Many times, a student may pose a question to the whole class. In this case, the instructor may prompt the students to discuss the issue in their groups. As long as their conversation remains on topic, which would require close monitoring, then the students are engaged. If during that time, a group were to ask the teacher a question related to their problem, the teacher has a couple of choices. He or she could give the students a direct answer, which would likely lead to the students accepting the teacher's answer and cease

thinking on their own, or the teacher could respond to the students by presenting a follow-up question then walking away for them to discuss their ideas and come up with an answer. The second scenario is one that is most likely to produce greatest engagement among that particular group of students.

A student may also ask a fellow student a question. If the first student gives a direct answer without encouraging the second student to think for him or herself, then the second student may become unengaged. However, if instead they discuss the possible answers with each other, then engagement would increase for both students involved. If, after the students' discussion, either student is able to apply what they concluded, then that student she is showing he or she learned from their conversation.

Showing work on the board

Displaying work on the board, or having a student write his or her steps for solving a problem is a tool that can incite classroom discourse, as well as engagement. As a student is showing his or her work on the board, another student may be able to either highlight a mistake or provide an alternate method of solving the problem. Having work on the board can also allow for classmates to ask a question related to the work shown. In both of these cases, the students involved are showing outward signs of engagement.

A less obvious situation in which students may or may not show outward engagement is when a student writes on the board and the class follows along, showing work on personal whiteboards. Some students may simply be mindlessly copying, and others may show no work at all. I propose, though, that even those students who are not showing work have the potential to be engaged if they are following along and

understanding the process – it is just not easily observable. Thus, if those students are able to explain the process in their groups or to the teacher, then they have shown evidence of previously being engaged with the material.

Nonverbal Attentiveness

Student engagement is not always displayed verbally. According to Frymier and Houser in "The Role of Oral Participation in Student Engagement" (2016), there are several indicators of nonverbal attentiveness – including note taking, eye contact, and head nods (p. 83). Many times, instructors, myself included, believe that if a student appears to be taking notes, then he or she is engaging in the lesson. However, the writing could be off-topic or homework for another class. The same applies to taking notes on a computer – the student may be playing an online game or typing a paper for English class. As the appearance of note taking alone cannot guarantee engagement, an instructor must be able to verify that a student was engaged by utilizing a form of formative assessment or informal check.

Similarly, if a student maintains eye contact with the instructor or with a peer, but is not absorbing any information, then that student is not engaged. However, if that student is actually paying attention and internalizing the material, then he or she is engaged. The student can show outward evidence of inward engagement by being able to solve a given problem. The same logic can be applied to a scenario in which a teacher or classmate proposes a question or asks for verification on a step, and a student nods his or her head in agreement along with the rest of the class. Based on these scenarios,

nonverbal attentiveness can be verified as engagement with the use of formative assessments.

Verification of student engagement using formative assessments

Suppose a teacher gives an opener to see what prerequisite skills the students have. Then, after presenting a block of instruction, the teacher presents a formative assessment. If the students show growth, despite not showing outward signs of behavioral engagement, then I would propose that they must have been engaged. If the student did not show outward signs of engagement, and was not able to show growth between assessments, then it is safe to conclude that he or she was not engaged during the instructional session. There must be evidence to support a student's engagement, or lack thereof. Thus, growth between formative assessments can be used as verification of engagement with mathematics.

While applying this concept, an instructor must be careful to not make assumptions about students' prior knowledge. For example, if a student did not show outward signs of engagement, but was later able to solve a problem related to the topic, this may not indicate engagement during that particular lesson – he or she may have already known how to solve that type of problem. However, if a student misses a problem on the opener, and is later able to solve a problem related to the question, showing growth, then that student was certainly engaged.

Working in groups

If students are working in groups, all of the previous occurrences of engagement are possible on a wider scale. For example, multiple cases of students asking fellow students questions could be happening at one time in multiple groups. Thus, the use of groups encourages greater engagement opportunities for the whole class.

Within the groups, there can also be signs of engagement. If one student solves a problem in a group consisting of three peers, and the other group members accept it as correct and do not contribute, then there is no assumption of engagement for the other two group members. If one student solves a problem in a group and a second student in the group finds a mistake and explains it, while the third student zones out, then the first two students are engaged while the third is not. However, if that third student asks a question about the process, then all group members are engaged.

Other occurrences of engagement within a group include students taking notes and writing the solution to a problem. Students may also work individually and then come back together to discuss their answers and different methods of solving. If two students in a group work together to solve a problem, and a third student listens along and introduces a new idea that is discussed among the group, then all three students are engaged. If the third student listens and pays attention but does not contribute, and is later able to solve a similar problem on his or her own, then all group members are engaged in an easily observable manner.

Differentiation

An instructor's use of differentiation in the classroom can also be an effective indicator of student engagement. Differentiation provides students a level of academic expertise out of their range through creating a supportive group environment, asking questions, or presenting problems suited for their current ability (Hattie, et al., 2017, p. 212). Suppose a student is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she has already completed the problems for the day, or is bored because he or she already knows the material. Essentially, that student has stopped thinking about and engaging with the mathematics. Thus, if the teacher presents that student with a challenge problem, then the student has the opportunity to become engaged. The student may or may not be able to complete the challenge problem, but if he or she continued to productively struggle with it instead of dismissing it, then the student remains engaged. Consider a student who is found not interacting with a teacher-planned activity or problem due to being frustrated with the difficulty of the problem. The instructor finds that he or she is unable to enter the task. In this case, the teacher can present the student with a problem more suited for his or her ability on the topic. The student can then display engagement by working on the problem for an allotted amount of time, even if he or she is not able to solve it completely. If the student is able to solve the problem and move on to a problem at the next level, then the student has shown growth with the material.

Suppose a student shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can provide support to students who have shown

they have some sort of misconception regarding that day's topic. Another option within the same scenario would be to place that student in a homogenous group in which he or she can work with his or her peers toward surpassing the goal through a challenge task. If a student shows that he or she has possible misconceptions regarding a topic based on the pre-assessments results, the instructor could place that student in a heterogeneous group in which he or she can receive support from his or her peers.

Differentiation using homogeneous groups consists of giving each group a task or scaffolded problem at the students' measured ability (based on timely formative assessments). What about differentiating in heterogeneous groups? One proposal is that when presenting a problem to a heterogeneous group, the students differentiate themselves by each working the part of the problem that they are able to solve, with the higher ability students scaffolding as necessary. This would require group norms to be set and for each group member to participate.

"In a differentiated classroom, flexible grouping is non negotiable" (Sousa and Tomlinson, 2018, p. 180), meaning to have a differentiated classroom, students must be in dynamic groups centered on the goal of the lesson. Students should be able to be moved in and out of groups based on need, which would, in turn, provide differentiation for those students. For example, if a group of students have shown mastery of the material, one option would be to present them with a challenge problem. Another option would be to utilize them as roaming leaders – sending them to help other groups, which also helps further solidify the material as they explain it to others. This option facilitates student-to-student interaction on a greater scale than having them remain stationary, working on a new problem. Another example of flexible grouping would be to separate a

group that is struggling with the material, and re-assign its members to new groups so they could receive support and help clarify their specific misconceptions. The use of flexible grouping requires the students to be familiar with their class' group norms, as well as close monitoring from the teacher to be able to make decisions about group structure in order to meet the needs of all students.

Summary of indicators

All the aforementioned engagement indicators – teacher-led questions, student-led questions, student showing work on the board, working in groups, formative assessment, nonverbal attentiveness, and differentiation – are included in the formalized indicator checklist, used for in-class observation of student engagement. The checklist is given in Figure 4, and an overview of the checklist (which only includes the indicator headings), is given in Figure 5.

An observer can filter the classroom occurrences through each indicator, and assign an engagement point each time one of the situations listed takes place, per student involved. For example, suppose the following takes place: Students 1 and 2 work together to solve a problem, Student 3 takes notes or writes the problem out. This occurrence would fall under the "Work in Groups" indicator, and since three students within the group were showing outward signs of engagement, three points would be added to the engagement tally within that category. At the end of the observation period, the observer would add up all the point from each indicator category to give an engagement score for "Total Engagement Indicators Fulfilled."

Indicator	Student Engagement
Teacher-Led Questions Engagement Total:	
Student-Led Questions Engagement Total:	
Work on the Board Engagement Total:	
Group Work Engagement Total:	
Student Growth → Engagement Total:	
Nonverbal Engagement Total:	
Differentiation Engagement Total:	
Engagement Indicator Checklist Score:	

Figure 5

The Engagement Indicator Checklist (Figure 4) can seem overwhelming to fill out during an instructional period, especially when trying to balance teaching and making detailed observations. Thus, I have created a series of Individual Student Checklists to allow for less time consuming notes, which can later be transferred to the more in-depth Engagement Indicator checklist. The student checklist categories can be altered depending on the type of instruction or the anticipated classroom occurrences for that day's particular task or activity. Figure 6, Figure 7, and Figure 8 are checklist templates for lecture, group work, and direct instruction respectively.

My experimental design consists of two major components - the Individual Student Checklist (Figures 6, 7, and 8) and the Engagement Indicator Checklist (Figure 4). I will use the Individual Student Checklist to record who participates in class, and then expound upon that data as I transfer it to the Engagement Indicator Checklist. I will then analyze my tables using a chi-square statistical test to see if there is significance in the results.

The students will experience classroom instruction as normal - including no changes to how I normally teach, the rules students are expected to follow, or how they are graded. The only difference is that I will be making my own observations and drawing conclusions using the tool I have developed. The data that is collected will be coded in such a way to protect the identity of each student and allow each individual to remain anonymous. My research is heavily qualitative, based on my observations and conclusions, with some quantitative aspects as I give an engagement score for a particular instructional period.

DATA COLLECTION

When implementing the Engagement Indicator Checklist that I developed, I was able to assign an engagement score to different teaching methods I implement – specifically, lecture, groups, and direct instruction - to come to a consensus on which method yields the greatest engagement potential. Before assigning each method a score, I first used the Individual Student Engagement Checklist given in Figures 6, 7, and 8 to gather student-specific data during the session to determine how many students appeared to be engaged at some point during each session.

Each instructional method session was implemented for roughly 10 minutes and with the same group of students. I structured each lesson such that they were sufficiently and equally interesting, thus minimizing the possibility that students were engaged based on interest instead of instructional method. Each student has been assigned a number and then given a checkmark for the areas of engagement that they displayed during each 10-minute session. If they did not display a particular sign of engagement, then they received an 'x.' If they received a '-' in the "shows growth" column, it is because they remained at the same mastery level from the formative assessment before the block of instruction, to the formative assessment at the end of the instructional block. 'N/A' indicates that the student was absent from class that day. At the end of the check sheet, I recorded how many students were engaged at some point during the session. The results are given in figures 9, 10, and 11.

As shown in Figure 9, during the lecture portion, there were 22 out of 24 students engaged at some point throughout the session, with 49 engagement occurrences. In the group portion, 24 out of 24 students were engaged at some point throughout the session, with 75 engagement indicators fulfilled (Figure 10). And in the direct instruction portion, there were 23 out of 24 students engaged at some point throughout the session, with 52 engagement indicators fulfilled (Figure 11). Those appear to be pretty high numbers, and a teacher should certainly be pleased to know that, at worst, about 92% of his or her class was engaged at some point. But I observed through my reflection of the class that some students were more engaged than others, though they all received one check mark for fulfilling an indicator at some point. The Engagement Indicator Checklist allowed me to rate the class based on each students' engagement progression, and then assign an engagement point for each indicator fulfilled, each time a student fulfilled it. I transferred the data from the Individual Student Checklist (Figures 9, 10, and 11) for each instructional method to the Engagement Indicator checklist, given in Figure 12, in order to assign each method a more accurate engagement score.

A summary of the results for each instructional method can be seen in Figure 13, and a more in-depth view of the results can be found in Figure 12 in the appendix.

Indicator	Lecture	Group	Direct
Teacher-Led Questions Engagement Total:	2	1	15
Student-Led Questions Engagement Total:	7	16	10
Work on the Board Engagement Total:	1	0	0
Group Work Engagement Total:	0	22	0
Student Growth → Engagement Total:	11	1	16
Nonverbal Engagement Total:	29	4	23
Differentiation Engagement Total:	0	40	0
Engagement Indicator Checklist Score:	**50**	**84**	**64**

Figure 13: Comparing Lecture, Group, and Direct Instruction

Lecture results

When transferred to the Engagement Indicator Checklist (Figure 12), the lecture session earned an engagement score of 50 (given in Total Engagement Indicators Fulfilled). During the lecture portion, the students were, for the most part, silently taking notes. Only two students answered when I asked questions, and only one student also asked me a question. That was the extent of student contribution to the lesson. I was the main talker during the class, giving me complete control of the direction of the lesson. There was very little student-to-student interaction. Four of the students that communicated with each other are part of a cluster that I refer to as "the usual suspects" – meaning they are the ones I can count on to participate no matter the instructional style (students 8, 9, 13, and 16). Two students verbally interacted during this lesson that normally do not (students 19 and 2). Students 10 and 6 are students who normally verbally participate but did not in this case.

As Student 11 reluctantly showed his work on the board, 17 out of 24 students paid attention, but no one contributed to the discussion by asking a question, clarifying steps, or discussing different methods of solving. Thus, the most engaged student at that point was the student who was actually working with the mathematics – Student 11.

The fifteen students that were taking notes were likely engaged, but it was obvious that some, like Student 6, were getting bored while taking notes. Fourteen students maintained eye contact, which is a good predictor of engagement, but it must be verified with the use of a formative assessment.

Eleven students showed growth between the pre-assessment and post-assessment for this block of instruction. Student 6 took notes, but did not maintain eye contact, and

Student 2 did not maintain eye contact nor take notes, but both students showed growth. Student 14 is interesting because he showed absolutely no signs of outward engagement, but still displayed growth between the pre and post-assessments. This observation suggests, though he did not verbally participate, take notes, nor make eye contact, he was still able to absorb and apply the information. Students 17 and 4 remained at the same level of mastery between assessments, one of which was in engaged in the lesson and the other was not. It was likely that the one who was not engaged already knew the material and did not benefit from revisiting it, showing a need for differentiation.

What is most worrisome about this data is that eleven people decreased in growth between the two assessments, and 9 of those students appeared to be engaged throughout the lesson. Student 25 appeared to be paying attention, but later told me that she zoned out, which would account for her decrease between assessments. I am sure that similar situations occurred throughout the class. The discovery of the decrease in growth leads me to believe that there was some misconception that was not addressed during the course of instruction. Since Student 17 was the only student who contributed to whole-class discussion, if he did not bring an idea or question to the table, it did not get addressed. The class structure did not allow for other students to confront their misconceptions. Thus, to remediate the situation, I could have taken those eleven students that showed growth and paired them up with the other eleven who decreased in growth, and had them talk about their misconceptions. I could have also paired up the two students that remained at the same high level and given them a challenge problem to work on.

Though at first it appeared 22 out of 24 students were engaged in the lecture, it is obvious that their level of engagement was shallow, at best. Many students showed an alarming decrease in growth, and two students actually fell asleep during the course of the lesson. While lecturing has its strengths in different situations, it is clear to me that this was not one of those cases. Based on the results shown in the Engagement Indicator Checklist, my instruction did not meet the needs of my students, nor did it properly engage them with the mathematics.

Group session results

The group session earned an engagement score of 84 on the Engagement Indicator Checklist. The groups were formed heterogeneously based on the students' opener results, with this group structure being a form of differentiation in and of itself. For example, based on her performance on the opener, I made Student 25 a leader of her group, though she is not normally a leader. She was able to work alongside Student 5 to support Student 22, who showed a need for remediation on this concept. Student 15 was entirely unengaged during the lecture but was able to work well with his peers in his group to interact with and discuss the mathematics. All groups appeared to be self-sufficient, and required little support. Though some groups did ask me questions from time to time, the students were able to discuss the problem amongst themselves and come to conclusions on issues with minor scaffolding on my part.

I observed from the opener that Students 24 and 19 could benefit from being placed with two strong leaders, Students 9 and 4. This group had the largest performance gap on the opener, with students 24 and 19 being the lowest two students and Students 9

and 4 being the highest, which may have led to them being the only group that did not remain engaged the entire class. They all worked well and discussed the task for the first half of the class, but Students 24 and 19 soon became unengaged. This observation leads me to believe that perhaps Students 9 and 4 were so far ahead that if affected the engagement of Students 24 and 19. Did they depend too heavily on the ideas of Students 9 and 4, without contributing much on their own? This situation would have been a good opportunity to regroup homogeneously, and give both groups an extra problem based on their current level (Students 9 and 4 could have worked on a challenge problem while 24 and 19 worked on a scaffolded, remediation problem).

Having the students in groups allowed me to implement widespread differentiation. I presented two groups two challenge problems as they finished the originally assigned task. This challenge allowed these students, as a group, to explore the topic a little deeper and think critically. For two other groups, I instructed them to move onto part two of the task, which was an extension worksheet to allow for more practice. I had the group composed of Students 24, 19, 4, and 9 work on an alternate assignment after they finished the original task – I allowed them to look at that evening's homework so that student 24 and 19 could receive some support from student 9 and 4. I presented differentiation to the group composed of Students 20, 6, and 2 in the form of scaffolded questioning. I had some remediation problems on hand in case a particular group appeared to be stuck, but I did not need them, as the groups were well formed and self-sufficient.

The pre and post assessments for the group session show that one student showed growth, one student declined, and the rest of the class remained at the same level. The

student that showed growth was Student 20, and was in a group with two other students who did a good job of engaging each other in discussion and working the problems together. Their group dynamic leads me to believe that working in a group is what enabled him to grow. The student that showed a decline in growth was Student 14 – a student who showed minimal engagement in his group, rarely contributing to discussion. I should have caught his disengagement earlier, and either encouraged him to participate or asked him a few questions regarding the topic in order to pinpoint and address his misconceptions. Since there was only one student who declined, it would be easy to remediate. As for the rest of the class, why did so many students remain constant? Perhaps they already had a good grasp of the material, and they needed to be challenged at a higher level than my differentiation allowed. This incident serves as a reminder to take into account the level at which students start a lesson in order to identify the next level of achievement, and establish how I will encourage them to get there. Since all students displayed verbal engagement within their groups throughout the session, it was not vital for them to also show growth as an indicator, as growth is primarily used to verify nonverbal engagement.

Overall, there was an increased amount of student-to-student interaction in the group session when compared to the lecture session. Every single student verbally participated with his or her group at some point, which encompasses the 18 students who did not contribute to discussion during the lecture**,** therefore greatly increasing the level of whole-class engagement. This result leads me to ask – do the students behave and interact in this manner naturally? Or is it due to the culture and norms I established? I would venture to say that establishing and enforcing group norms is what enriches and

encourages stimulating group experiences. In the specific group session observed, all 24 students were engaged, and, according to the Engagement Indicator Checklist, on a deeper level when compared to the lecture session.

Direct Instruction Results

The direct instruction portion earned an engagement score of 64 on the Engagement Indicator Checklist. From the front of the room, the direct instruction portion appeared to lend to a good discussion, where all parts of the room contributed. But when I looked at who actually spoke, it was only a handful of people that verbally participated – 10 to be exact, which is less than half the class. The rest of the class either showed non-verbal engagement or none at all, which is a stark contrast to the group session where every student was engaged in discussion with their peers.

Three students, 1, 12, and 19, were students who do not normally participate in whole group discourse but did during this lesson. A possible reason for the increased participation from these students is that they may have felt comfortable with the topic, or they felt more included in the discussion by the way I addressed the class, which may have given them the confidence to contribute. There was a productive progression of student-to-student interactions during this portion of instruction. For example, Student 11 asked a question, which was answered by Student 10. Then Student 10 answered a question I proposed. Student 8 disagreed with Student 10's answer, making an observation that addressed a common misconception, which was pivotal for the whole class to note. Then, Student 8 and Student 9 both argued their case for the final answer, and we were able to draw closure on that problem based entirely on student input.

There was also an increased amount of individual student-to-student interactions when compared to the lecture, though not as much as the group session. It started after Students 17 and 5 were discussing alternate ways to solve the opener problem. Student 5 was obviously ahead of the lesson and had a solid base understanding of the material. He was able to discuss a new method of solving the problem with Student 17. Student 10 was listening in on their conversation, though he did not contribute. Student 10 then turned to Student 19 and explained the same concept to him, showing that he was engaged in the discussion without verbally participating. This chain of interactions later served to enrich the whole-class discussion. Student 5 never contributed to the whole-class discourse, but Students 17 and 10 were able to bring his ideas to the table. Thus, he was given a voice through the aid of his peers. Toward the middle of the whole-class discussion, I put the cluster of students surrounding Students 17, 10, 19, and 5 on pause, as they began controlling the course of the discussion, and I wanted to further engage students in other parts of the class. There are a few possible reasons why these specific students participated. Was it because they are frequently grouped together? Was it the context of the problem at hand? Or did they simply find the task interesting? These questions are important to consider when looking at discourse results.

Students 22 and 25 were both students who did not verbally engage in the whole group discourse, but did individually ask me a question later, showing they were paying attention during the discussion. Student 14, on the other hand, did not engage in the discussion at all, similar to the lecture. The only class in which he engaged was the group session. A way to involve this student and give him a voice would be to allow for a mini group discussion before bringing everyone together as a class. That way he could discuss

his ideas in a smaller setting, and a peer would be the one to bring those ideas to the table.

Students 16, 13, and 7 shared a common misconception on the post-assessment. Since they were sitting in the same area of the classroom, I believe that they were likely unengaged at the same time and missed a vital piece of information. Better monitoring in order to include all students would have accounted for that brief, but detrimental, disengagement. Student 8 showed a decline in growth, though he was active in the discussion. His performance suggests that I was unable to identify and address his misconception during the discussion.

It is also important to note that I did not provide differentiation for students during this direct instruction session, though it is possible to do so. If I had provided differentiation opportunities, some students, such as 16, 13, and 7, could have had a greater chance of showing growth on the post assessment.

Student 6, who normally participates, did not in this case. Which leads me to ask, why did he not participate today? I need to look more closely at cases like his and make sure that I provide ample opportunity for all to be involved. A big issue is that I did not look at the whole class when I led the discussion. Could that be the reason he, and others, did not participate – since I appeared to be excluding them from the conversation? Being more inclusive in leading discussions is something to keep in mind, for which I can easily account by walking around the room instead of staying near the front of class.

Overall, the direct instruction showed an increase in engagement from the lecture, but a decrease in engagement from the group session. It can be very easy to slip from a rich, student-directed discussion into a teacher-controlled lecture. I have unfortunately

experienced such a situation, leading to an instructional period where only 21 out of 24 students were engaged, earning a low score of 31 on the Engagement Indicator Checklist during a 10-minute period (see Figures 14 and 15 in appendix).

A deeper look at each instructional method

While calculating the number of engagement occurrences during each instructional method, the numbers were not as high as I had anticipated, specifically for the group session. As each group consisted of three to four members, with each member remaining engaged throughout the entire 10 minute span, I would expect there to be a high number of engagement indicators fulfilled per group. Since trying to capture every single engagement occurrence for 24 students can be an overwhelming task, I decided to focus on one group of three. Instead of noting engagement every minute or so, as done previously, I noted engagement about every 10 seconds. This method of collecting engagement results allows for a more continuous look at the group. The results, given in Figure 17, show that the individual group earned an engagement score of 127, which is substantially higher than the score given for the entire class (which was 84). Figure 16 in the appendix gives a more in-depth view of how I arrived at this score. If each group followed a similar pattern, then the class, as a whole, would earn an engagement score greater than 1,000.

Indicator	Group: Continuous
Teacher-Led Questions Engagement Total:	0
Student-Led Questions Engagement Total:	18
Work on the Board Engagement Total:	0
Group Work Engagement Total:	52
Student Growth → Engagement Total:	0
Nonverbal Engagement Total:	48
Differentiation Engagement Total:	9
Engagement Indicator Checklist Score:	**127**

Figure 17: A continuous look at one group

I repeated the aforementioned process for both the lecture and the direct instruction session, focusing on three students. The results are given in Figure 19 and Figure 21, with in-depth views given in Figure 18 and Figure 20 in the appendix. The change was not quite as significant for these methods. The biggest difference arose in the nonverbal engagement indicator, as eye contact and note taking remained fairly consistent for the students who were engaged. It is important to note that the amount of verbal engagement remained low in these two methods, since it is usually the case that only person is talking or interaction at a time during whole-class activities. On the other hand, the group session allowed for all 24 to be active in discussion at the same time.

Indicator	Lecture: Continuous
Teacher-Led Questions Engagement Total:	0
Student-Led Questions Engagement Total:	0
Work on the Board Engagement Total:	0
Group Work Engagement Total:	0
Student Growth → Engagement Total:	1
Nonverbal Engagement Total:	75
Differentiation Engagement Total:	0
Engagement Indicator Checklist Score:	**76**

Figure 19: A continuous look at lecture

Indicator	Direct Instruction: Continuous
Teacher-Led Questions Engagement Total:	4
Student-Led Questions Engagement Total:	9
Work on the Board Engagement Total:	0
Group Work Engagement Total:	0
Student Growth → Engagement Total:	2
Nonverbal Engagement Total:	79
Differentiation Engagement Total:	0
Engagement Indicator Checklist Score:	**94**

Figure 21: A continuous look at direct instruction

Statistical test of results

As the data collected is concerned with more than one variable, contingency tables were employed. The Chi-Square test, with 12 degrees of freedom (from the 3 columns and 7 rows), shows that the results are significant at any testable level – meaning that the differences of A, B, and C (lecture, groups, and direct instruction, respectively) are not random, and they must have some sort of causation. The statistical test for the data from the original, whole-class method comparison as well as for the continuous record are given in Figure 22 and Figure 23 respectively.

When looking at the indicator categories in Figure 22, one might call to question the drastic difference between A, B, and C in indicators 4, 6, and 7 (group work total, nonverbal engagement total, and differentiation engagement total, respectively). In indicator 4, both lecture (A) and direct instruction (C) received a score of 0, while groups (B) received a score of 22. This difference was expected, as working in groups is not a natural component in a lecture or direct instruction. Indicator 7 also shows that lecture and direct instruction have a score of 0, but in this case groups has a score of 40. Indicator 7 correlates with differentiation, which is typically not implemented during a lecture or direct instruction. While it is possible to incorporate differentiation, specifically during direct instruction, it will often shift the mode of the instruction to either a problem set or group work. Indicator 6, nonverbal engagement, shows a substantially higher score for lecture and direct instruction as compared to groups. Since only one person can be active in discussion at a time, the remainder of the class will show signs of nonverbal engagement. The same differences in the data reappear in Figure 23, which is the fine grain view of the class.

Results of a contingency table X^2 statistical test

Data: contingency table

	A	B	C	
1	2	1	15	18
2	7	16	10	33
3	1	0	0	1
4	0	22	0	22
5	11	1	16	28
6	29	4	23	56
7	0	40	0	40
	50	84	64	198

Expected: contingency table

	A	B	C
1	4.55	7.64	5.82
2	8.33	14.0	10.7
3	0.253	0.424	0.323
4	5.56	9.33	7.11
5	7.07	11.9	9.05
6	14.1	23.8	18.1
7	10.1	17.0	12.9

Chi-square = 160

Degrees of freedom = 12

Probability = 0.000

Figure 22: Original whole-class

Results of a contingency table X^2 statistical test

Data: contingency table

	A	B	C	
1	0	0	4	4
2	0	18	9	27
3	1	0	0	1
4	0	52	0	52
5	1	0	2	3
6	75	48	79	202
7	0	9	0	9
	77	127	94	298

Expected: contingency table

	A	B	C
1	1.03	1.70	1.26
2	6.98	11.5	8.52
3	0.258	0.426	0.315
4	13.4	22.2	16.4
5	0.775	1.28	0.946
6	52.2	86.1	63.7
7	2.33	3.84	2.84

Chi-square = 137

Degrees of freedom = 12

Probability = 0.000

Figure 23: Continuous record

Instructional method conclusion

Based on the results provided by the Engagement Indicator Checklist, as well as the data gathered from the continuous look at each method, the use of groups in a classroom fosters greater opportunity for student engagement to take place in a set amount of time when compared to lecture and direct instruction. Groups had, by far, the greatest amount of interactions, as indicated by the Engagement Indicator score. The device itself highlighted the strengths and weaknesses of each instructional method as they relate to engagement, which is shown in the sub-scores for each indicator. It is up to the teacher to decide which instructional method is appropriate to create the conditions in

which students can be engaged, and he or she should take into account both the goal of the day and the material. Thus, he or she acts as a facilitator of engagement by presenting opportunities for students to be involved with the mathematics. According to my research, the use of groups in the classroom enriches the environment for such student engagement by making it possible on a wider scale.

INTERPRETATION

Engagement can be seen as both classroom participation, or as growth shown by the students regarding the concept covered in the lesson. As engagement with mathematics plays a pivotal role in success in a mathematics course, I took an interest in exploring how student engagement can be identified and under what circumstances it flourishes. This interest was all a part of my endeavor to best serve and educate my future students. I ventured to ask the questions, how can I easily observe and make note of students who are engaged with the material? And, do some instructional strategies promote more students to be engaged, and on a deeper level, than others?

In order to answer the first question, how can I easily observe and make note of students who are engaged with the material? I had to first define what engagement looked like by exploring the different classroom occurrences that yield engagement. The indicators I developed include teacher-led questions, student-led questions, a student showing his or her work on the board, non-verbal attentiveness, showing growth in formative assessments, students working in groups, and the use of differentiation to keep students engaged. I compiled these indicators into an Engagement Indicator Checklist (Figure 1), that a classroom observer can use to verify if a student is engaged and give an overall engagement score for the class as a whole. As the Engagement Indicator Checklist is quite detailed and can be difficult to fill out during an instructional period, I also developed Individual Student Engagement Checklists (Figures 2, 3, and 4), which can later be transferred to the Engagement Indicator Checklist.

Once I developed the Engagement Indicator Checklist, I was able to address my second question – do some instructional strategies promote more students to be engaged, and on a deeper level, than others? When comparing the instructional methods of lecture, groups, and direct instruction using the Engagement Indicator Checklist (Figure 8), the use of groups fostered greater opportunity for student engagement to take place.

"The bigger conversation... is to show how teachers can choose the right approach at the right time to ensure learning..." (Hattie, et al., 2017, p. 24). Precision teaching is about knowing what strategies to implement when for maximum impact (Hattie, et al., 2017, p. 26). The best way to instruct a mathematics class is to use a variety of approaches that align with the goal of the lesson. It is up to the teacher to decide which instructional method is appropriate to create the conditions in which students can be engaged, and he or she should take into account both the goal of the day and the material. Though, according to my research, utilizing groups has the potential to maximize the opportunity for students to be involved and engaged with the mathematics.

LIMITATIONS AND FURTHER RESEARCH

There were a few limitations to my research that are worth exploring in the future. One was that my evaluation of student growth did not account for the students who already had the prerequisite skills given in the pre-assessments. This issue was particularly prevalent for the group session, which is why the majority of the class are shown as having no substantial growth. Another limitation of my study is that, due to my practicum experience placement and the differences in the class I teach, I did not have the opportunity to teach the same lesson to three different Algebra II groups using the different instructional approaches of lecture, groups, and direct instruction. In the future, I would like to further explore the idea of engagement as it relates to instructional methods by comparing the methods used in different classes, centered on the same general lesson. I will conduct the same research, but by implementing the same lesson three times, once with a lecture, once with groups, and once with direct instruction. Doing so would help minimize the issue of whether or not students are engaged due to the interest of the task or topic, since each method would be covering the same material. Continuing this study is important to me as an educator since each method of instruction supports particular indicators.

Through my explorations on student engagement and the methods that best promote it, I have laid the groundwork for future research in this area. A few topics to consider include group structure and classroom structure.

I have established that the use of well-formed groups promotes student engagement, but which structure will yield the greatest opportunity for engagement in different situations? What if I am conducting a test review, how should I form groups? Or what if I am introducing a new concept? Would the two require different structures to maximize engagement? If so, which structures work best in each context? While researching the engagement of different instructional methods, I often conducted a group work session first, and then brought everyone together for a whole class discourse. If I switched the order of group work and whole class discourse, what would occur? Would there be less, equal, or more student engagement in this case? If I begin a lesson using a particular approach or particular groups, and halfway through I decide to restructure the class and engagement picks up, why did I feel the need to restructure? What happened to cause an increase in engagement? These are all questions I would like to pursue as I further my research on the topic of student engagement.

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APPENDIX

Figure 1: Group ZPD

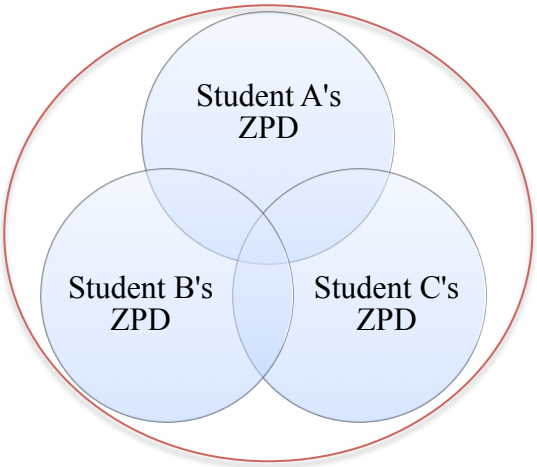

Figure 2: Group norms

Figure 3: Standards for Mathematical Practice

MP1	Make sense of problems and persevere in solving them.	Mathematically proficient students are students who approach a problem "by explaining to themselves the meaning of a problem and looking for entry points to its solution." They also analyze what is given to them in the problem as well as possible constraints, relationships, and goals. They evaluate their progress and change their approach or method if needed. They then check their answers and make sure it makes sense.
MP2	Reason abstractly and quantitatively.	According to the Standards for Mathematical Practice, students are able to *decontextualize* and *contextualize*. They are able to consider units, attend to the meaning of quantities (not just how to compute them), and use different properties of operations.
MP3	Construct viable arguments and critique the reasoning of others.	"Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures." These students are able to justify their conclusions and well as communicate and defend their findings. They are also able to distinguish correct and flawed reasoning or logic, as well as explain any flaws they found. Students can also "listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments." Essentially, this practice is all about being able to communicate the math that is occurring in the classroom and make a case for particular methods or solutions.
MP4	Model with mathematics.	If a student is modeling with mathematics, he or she is engaging with a problem that may arise in everyday life. Students must apply what they know to make assumptions, and then be able to identify important quantities to be able to model the relationship. They then analyze the relationship to draw conclusions and interpret their results in the context of the problem, after which they improve the model if necessary.
MP5	Use appropriate tools strategically.	"Mathematically proficient students consider the available tools when solving a mathematical problem." Tools can include, but are not limited to, "pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software." Students utilize appropriate tools when constructing a mathematical model to help them visualize results, explore potential consequences, and compare predictions. These students use appropriate tools in order to deepen their conceptual understanding of a mathematical topic or task.
MP6	Attend to precision.	Mathematically proficient students will incorporate an adequate level of precision appropriate for the problem at hand. They do so by specifying units and labeling axes consistently. They are able to communicate precisely to others by using clear definitions and clarifying the meaning of any symbols they use.
MP7	Look for and make use of structure.	"Mathematically proficient students notice if calculations are repeated, and look both for general methods and shortcuts." In looking for and making use of structure, students discern the structure or pattern of the problem and are able to "step back for an overview and shift perspective." Students enacting these practices are able to actively notice patterns and make connections to help them solve future problems or make generalities.
MP8	Look for and express regularity in repeated reasoning.	

Source: *Standards for Mathematical Practice* | *Common Core State Standards Initiative*, 2018

Figure 4: Engagement Indicator Checklist

Indicator	Student Engagement
Teacher-Led Questions	
Teacher asks question, student answers	
Teacher asks question, students reply individually on whiteboards after an adequate wait time - whiteboards are shown at the same time	
Teacher asks question, students are to discuss their responses among themselves (yes if on-topic discussion, which would require close monitoring).	
Teacher-Led Questions Engagement Total:	
Student-Led Questions	
Student A asks teacher a question related to the topic	
Student B asks either the teacher or Student A a follow up question	
Student B responds to Student 1's question	
Student B then turns to Student C and shows he/she learned from Student A (yes twice)	
Student asks a question to the whole class, teacher prompt students to discuss the issue in their groups (yes when on topic, which would require close monitoring).	
A group asks the teacher a question, teacher responds by presenting a follow-up question. The group then discusses their ideas, and everyone participates.	
Student A asks Student B a question, Student B discusses the possible answer with Student A	
Student A asks Student B a question; Student B discusses the possible answer with Student A. Student A shows he/she understood/learned from Student A.	
Student-Led Questions Engagement Total:	

Figure 4 continued

Indicator	Student Engagement
Student Shows Work on the Board	
Student writes on the board (one student engaged)	
Student writes on the board and a classmate catches and explains a mistake or provides alternate method (2 students engaged)	
Student writes on the board and classmate asks a question (2 students engaged)	
Student writes on the board and the class follows along, showing their work on their whiteboards. One student does not show work but is able to explain the process in his or her group or to the teacher	
Student writes on the board and the class follows along, showing their work on their whiteboards. Then they get in groups and defend their answer/method	
Work on the Board Engagement Total:	
Work in Groups	
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C zones out (A and B engaged, C is not)	
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C asks a question about the process	
Students A and B work together to solve a problem, Student C takes notes or writes the problem out	
Students A, B, and C work independently to solve a problem then come together to discuss their answers and/or different methods of solving, all participate in discussion	
Students A and B work together to solve the problem, Student C listens along and then introduces a new idea that is discussed among the group	
Students A and B discuss the problem, Student C listens and pays attention but does not contribute, but is later able to solve a similar problem on his or her own	
Group Work Engagement Total:	

Figure 4 continued

Indicator	Student Engagement
Formative Assessment - used to verify engagement	
Teacher gives an opener then presents a block of instruction. Student may or may not show outward signs of behavioral engagement. Teacher then presents a formative assessment and the student shows growth.	
Student Growth → Engagement Total:	
Nonverbal Attentiveness	
Proposal: nonverbal attentiveness can be verified as engagement with the use of formative assessments, as mentioned in the last section. Nonverbal attentiveness scenarios given below.	
Note Taking	
The teacher is leading instruction and a student does not verbally participate but is taking detailed notes on a piece of paper (yes if notes on topic, which would require close monitoring).	
A student has his or her computer out and is very focused on it as he or she takes notes on the material (yes if notes on topic, which would require close monitoring).	
Note: As the appearance of note taking alone cannot guarantee engagement (a student could actually be writing or typing something unrelated to the material), an instructor must be able to verify that a student was engaged with the use of formative assessments	
Eye contact	
A student makes eye contact either with the instructor or with the student talking and is paying attention, and proves it by being able to solve the given problem even though he or she did not verbally participate	
Head nods	
A teacher or classmate proposes a question or asks for verification on a step, Student A nods his or her head in agreement along with the rest of the class, and is able to solve a problem related to the question	
Student A misses a problem on an opener. A teacher or classmate proposes a question or asks for verification on a step related to that opener problem; Student A nods his or her head in agreement along with the rest of the class. Later, Student A is able to solve a problem related to the question (showing growth)	
Nonverbal Engagement Total:	

Figure 4 continued

Indicator	Student Engagement
Differentiation	
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can provide support to students who have shown they have some sort of misconception regarding that day's topic.	
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a homogenous group in which he or she can work with his or her peers to work toward surpassing the goal via a challenge problem.	
Student B shows that he or she has possible misconceptions regarding a topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can receive support from his or her peers.	
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher presents Student B with a leading question to him or her better understand the problem or material. Student B is then able to enter the task and work on the problem.	
Student A is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she has already completed the problems for the day. The teacher gives Student A a challenge problem to work on. Student A works on the problem the rest of class and may or may or not be able to solve it. (If not participating in class discussion, but working on assigned problems, still engaged.)	
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to enter the task, works on the problem for the rest of class and may or may not be able to solve it and may or may not have any other interactions with the class.	
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to solve the problem and move onto a problem at the next level **(yes, Student B showed growth)**	
Differentiation Engagement Total:	
Engagement Indicator Checklist Score:	

Figure 5: Summary of engagement indicators

Indicator	Student Engagement
Teacher-Led Questions Engagement Total:	
Student-Led Questions Engagement Total:	
Work on the Board Engagement Total:	
Group Work Engagement Total:	
Student Growth → Engagement Total:	
Nonverbal Engagement Total:	
Differentiation Engagement Total:	
Engagement Indicator Checklist Score:	

Figure 6: Student engagement during a lecture

Student	Answered teacher's question	Asked a question	Showed work on the board	Student to student interaction	Took notes	Nonverbal engagement (eye contact/head nods)	Growth
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
Total							
Indicators							

Figure 7: Student engagement during a group work session

Student	Asked teacher a question	Asked a peer a question	Showed work	Contributed to discussion	Group differentiation	Growth
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
Total						
Indicators						

Figure 8: Student engagement during a direct instruction session

Student	Asked teacher a question	Asked a peer a question	Responded to peer	Responded to teacher	Contributed to discussion	Took notes	Nonverbal engagement (eye contact/head nod)	Growth
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
Total								
Indicators								

Figure 9: Student engagement during a 10-minute lecture

Student	Answered teacher's question	Asked a question	Showed work on the board	Student to student interaction	Took notes	Nonverbal engagement (eye contact/head nods)	Growth
1	X	X	X	X	✓	✓	✓
2	X	X	X	✓	X	X	✓
3	X	X	X	X	✓	✓	X
4	X	X	X	X	X	X	-
5	X	X	X	X	✓	✓	✓
6	X	X	X	X	✓	X	✓
7	X	X	X	X	✓	✓	X
8	X	X	X	✓	X	✓	✓
9	X	X	X	✓	✓	✓	✓
10	X	X	X	X	✓	✓	✓
11	X	X	✓	X	✓	✓	X
12	X	X	X	X	✓	X	X
13	X	X	X	✓	✓	✓	X
14	X	X	X	X	X	X	✓
15	X	X	X	X	X	X	X
16	X	X	X	✓	X	X	X
17	✓	✓	X	X	✓	✓	-
18	X	X	X	X	✓	✓	X
19	X	X	X	✓	X	✓	✓
20	X	X	X	X	X	✓	✓
21	X	X	X	X	✓	X	✓
22	X	X	X	X	✓	X	X
23	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Figure 9 continued

Student	Answered teacher's question	Asked a question	Showed work on the board	Student to student interaction	Took notes	Nonverbal engagement (eye contact/head nods)	Growth
24	X	X	X	X	X	X	X
25	✓	X	X	X	✓	✓	X
Total	**2**	**1**	**1**	**6**	**15**	**14**	**10**
Indicators	**49**						

Figure 10: Student engagement during a 10-minute group work session

Student	Asked teacher a question	Asked a peer a question	Showed work	Contributed to discussion	Group differentiation	Growth
1	X	X	✓	✓	X	-
2	✓	X	✓	✓	✓	-
3	✓	✓	✓	✓	X	-
4	✓	X	✓	✓	✓	-
5	✓	X	✓	✓	X	-
6	✓	X	✓	✓	✓	-
7	X	✓	✓	✓	✓	-
8	X	X	✓	✓	✓	-
9	✓	X	X	✓	X	-
10	X	✓	✓	✓	✓	-
11	X	✓	X	✓	X	-
12	X	X	X	✓	✓	-
13	✓	✓	✓	✓	✓	-
14	X	X	X	✓	✓	X
15	X	✓	✓	X	X	-
16	N/A	N/A	N/A	N/A	N/A	N/A
17	X	✓	✓	✓	✓	-
18	✓	X	X	✓	✓	-
19	✓	✓	X	✓	X	-
20	✓	X	X	✓	✓	✓
21	✓	X	✓	✓	✓	-
22	✓	X	X	✓	X	-
23	X	✓	X	✓	✓	-

Figure 10 continued

Student	Asked teacher a question	Asked a peer a question	Showed work	Contributed to discussion	Group differentiation	Growth
24	✓	X	X	✓	X	-
25	✓	X	✓	✓	X	-
Total	**14**	**9**	**14**	**23**	**14**	**1**
Indicators	**75**					

Figure 11: Student engagement during a 10-minute direct instruction session

Student	Asked teacher a question	Asked a peer a question	Responded to peer	Responded to teacher	Contributed to discussion	Took notes	Nonverbal engagement (eye contact/head nod)	Growth
1	X	X	X	✓	X	✓	✓	-
2	X	X	X	X	X	X	✓	✓
3	X	X	X	X	X	✓	✓	✓
4	X	X	X	X	X	X	✓	-
5	X	X	X	X	✓	X	✓	-
6	X	X	X	X	X	✓	✓	✓
7	X	X	X	X	X	X	✓	✓
8	X	X	X	✓	✓	X	✓	X
9	X	X	X	✓	✓	X	✓	-
10	✓	X	✓	✓	X	✓	✓	✓
11	✓	✓	X	✓	X	X	✓	✓
12	X	X	X	✓	X	X	✓	✓
13	X	X	X	✓	X	X	X	X
14	X	X	X	X	X	X	X	-
15	X	X	X	X	X	X	✓	✓
16	✓	X	X	✓	X	X	✓	✓
17	X	X	X	✓	X	X	✓	✓
18	X	X	X	X	X	X	✓	-
19	X	X	X	✓	X	X	✓	✓
20	X	X	X	X	X	X	X	✓
21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22	✓	X	X	X	X	X	✓	✓

Figure 11 continued

Student	Asked teacher a question	Asked a peer a question	Responded to peer	Responded to teacher	Contributed to discussion	Took notes	Nonverbal engagement (eye contact/head nod)	Growth
23	X	X	X	X	X	X	✓	✓
24	X	X	X	X	X	X	X	✓
25	✓	X	X	X	X	X	X	✓
Total	**5**	**1**	**1**	**10**	**3**	**4**	**19**	**9**
Indicators	**52**							

Figure 12: Lecture vs. Group vs. Direct Instruction

Indicator	Lecture	Group	Direct
Teacher-Led Questions			
Teacher asks question, student answers	2	0	10
Teacher asks question, students reply individually on whiteboards after an adequate wait time - whiteboards are shown at the same time	0	0	0
Teacher asks question, students are to discuss their responses among themselves (yes if on-topic discussion, which would require close monitoring).	0	1	5
Teacher-Led Questions Engagement Total:	2	1	15
Student-Led Questions			
Student A asks teacher a question related to the topic	1	2	7
Student B asks either the teacher or Student A a follow up question	0	0	1
Student B responds to Student A's question	0	1	1
Student B then turns to Student C and shows he/she learned from Student 1 (yes twice)	0	0	0
Student asks a question to the whole class, teacher prompt students to discuss the issue in their groups (yes when on topic, which would require close monitoring).	0	0	0
A group asks the teacher a question, teacher responds by presenting a follow-up question. The group then discusses their ideas, and everyone participates.	0	4	0
Student A asks Student B a question, Student B discusses the possible answer with Student A	2	0	0
Student A asks Student B a question; Student B discusses the possible answer with Student A. Student A shows he/she understood/learned from Student B.	4	9	1
Student-Led Questions Engagement Total:	7	16	10

Figure 12 continued

Indicator	Lecture	Group	Direct
Student Shows Work on the Board			
Student writes on the board (one student engaged)	1	N/A	N/A
Student writes on the board and a classmate catches and explains a mistake or provides alternate method (2 students engaged)	0	N/A	N/A
Student writes on the board and classmate asks a question (2 students engaged)	0	N/A	N/A
Student writes on the board and the class follows along, showing their work on their whiteboards. One student does not show work but is able to explain the process in his or her group or to the teacher	0	N/A	N/A
Student writes on the board and the class follows along, showing their work on their whiteboards. Then they get in groups and defend their answer/method	0	N/A	N/A
Work on the Board Engagement Total:	1	0	0
Work in Groups			
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C zones out (A and B engaged, C is not)	N/A	0	N/A
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C asks a question about the process	N/A	2	N/A
Students A and B work together to solve a problem, Student C takes notes or writes the problem out	N/A	14	N/A
Students A, B, and C work independently to solve a problem then come together to discuss their answers and/or different methods of solving, all participate in discussion	N/A	0	N/A
Students A and B work together to solve the problem, Student C listens along and then introduces a new idea that is discussed among the group	N/A	1	N/A
Students A and B discuss the problem, Student C listens and pays attention but does not contribute, but is later able to solve a similar problem on his or her own	N/A	5	N/A
Group Work Engagement Total:	0	22	0

Figure 12 continued

Indicator	Lecture	Group	Direct
Formative Assessment – used to verify engagement			
Teacher gives an opener then presents a block of instruction. Student may or may not show outward signs of behavioral engagement. Teacher then presents a formative assessment and the student shows growth.	11	1	16
Student Growth → Engagement Total:	11	1	16
Nonverbal Attentiveness			
Proposal: nonverbal attentiveness can be verified as engagement with the use of formative assessments, as mentioned in the last section. Nonverbal attentiveness scenarios given below.			
Note Taking			
The teacher is leading instruction and a student does not verbally participate but is taking detailed notes on a piece of paper (yes if notes on topic, which would require close monitoring).	13	0	4
A student has his or her computer out and is very focused on it as he or she takes notes on the material (yes if notes on topic, which would require close monitoring).	2	0	0
Note: As the appearance of note taking alone cannot guarantee engagement (a student could actually be writing or typing something unrelated to the material), an instructor must be able to verify that a student was engaged with the use of formative assessments			
Eye contact			
A student makes eye contact either with the instructor or with the student talking and is paying attention, and proves it by being able to solve the given problem even though he or she did not verbally participate	13	4	19

Figure 12 continued

Indicator	Lecture	Group	Direct
Head nods			
A teacher or classmate proposes a question or asks for verification on a step, Student A nods his or her head in agreement along with the rest of the class, and is able to solve a problem related to the question	1	0	0
Student A misses a problem on an opener. A teacher or classmate proposes a question or asks for verification on a step related to that opener problem; Student A nods his or her head in agreement along with the rest of the class. Later, Student A is able to solve a problem related to the question (showing growth)	0	0	0
Nonverbal Engagement Total:	29	4	23
Differentiation			
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can provide support to students who have shown they have some sort of misconception regarding that day's topic.	0	13	0
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a homogenous group in which he or she can work with his or her peers to work toward surpassing the goal via a challenge problem.	0	0	0
Student B shows that he or she has possible misconceptions regarding a topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can receive support from his or her peers.	0	11	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher presents Student B with a leading question to him or her better understand the problem or material. Student B is then able to enter the task and work on the problem.	0	2	0
Student A is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she has already completed the problems for the day. The teacher gives Student A a challenge problem to work on. Student A works on the problem the rest of class and may or may or not be able to solve it. (If not participating in class discussion, but working on assigned problems, still engaged.)	0	14	0

Figure 12 continued

Indicator	Lecture	Group	Direct
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to enter the task, works on the problem for the rest of class and may or may not be able to solve it and may or may not have any other interactions with the class.	0	0	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to solve the problem and move onto a problem at the next level **(yes, Student B showed growth)**	0	0	0
Differentiation Engagement Total:	0	40	0
Engagement Indicator Checklist Score:	**50**	**84**	**64**

Figure 13: Comparing Lecture, Group, and Direct Instruction Summary

Indicator	Lecture	Group	Direct
Teacher-Led Questions Engagement Total:	2	1	15
Student-Led Questions Engagement Total:	7	16	10
Work on the Board Engagement Total:	1	0	0
Group Work Engagement Total:	0	22	0
Student Growth → Engagement Total:	11	1	16
Nonverbal Engagement Total:	29	4	23
Differentiation Engagement Total:	0	40	0
Engagement Indicator Checklist Score:	**50**	**84**	**64**

Figure 14: Direct instruction turned lecture

Indicator	Student Engagement
Teacher-Led Questions	
Teacher asks question, student answers	4
Teacher asks question, students reply individually on whiteboards after an adequate wait time - whiteboards are shown at the same time	0
Teacher asks question, students are to discuss their responses among themselves (yes if on-topic discussion, which would require close monitoring).	0
Teacher-Led Questions Engagement Total:	4
Student-Led Questions	
Student A asks teacher a question related to the topic	1
Student B asks either the teacher or Student A a follow up question	1
Student B responds to Student A's question	0
Student B then turns to Student C and shows he/she learned from Student A (yes twice)	0
Student asks a question to the whole class, teacher prompt students to discuss the issue in their groups (yes when on topic, which would require close monitoring).	0
A group asks the teacher a question, teacher responds by presenting a follow-up question. The group then discusses their ideas, and everyone participates.	0
Student A asks Student B a question, Student B discusses the possible answer with Student A	0
Student A asks Student B a question; Student B discusses the possible answer with Student A. Student A shows he/she understood/learned from Student B.	0
Student-Led Questions Engagement Total:	2

Figure 14 continued

Indicator	Student Engagement
Student Shows Work on the Board	
Student writes on the board (one student engaged)	0
Student writes on the board and a classmate catches and explains a mistake or provides alternate method (2 students engaged)	0
Student writes on the board and classmate asks a question (2 students engaged)	0
Student writes on the board and the class follows along, showing their work on their whiteboards. One student does not show work but is able to explain the process in his or her group or to the teacher	0
Student writes on the board and the class follows along, showing their work on their whiteboards. Then they get in groups and defend their answer/method	0
Work on the Board Engagement Total:	0
Work in Groups	
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C zones out (A and B engaged, C is not)	0
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C asks a question about the process	0
Students A and B work together to solve a problem, Student C takes notes or writes the problem out	0
Students A, B, and C work independently to solve a problem then come together to discuss their answers and/or different methods of solving, all participate in discussion	0
Students A and B work together to solve the problem, Student C listens along and then introduces a new idea that is discussed among the group	0
Students A and B discuss the problem, Student C listens and pays attention but does not contribute, but is later able to solve a similar problem on his or her own	0
Group Work Engagement Total:	0

Figure 14 continued

Indicator	Student Engagement
Formative Assessment - used to verify engagement	
Teacher gives an opener then presents a block of instruction. Student may or may not show outward signs of behavioral engagement. Teacher then presents a formative assessment and the student shows growth.	2
Student Growth → Engagement Total:	2
Nonverbal Attentiveness	
Proposal: nonverbal attentiveness can be verified as engagement with the use of formative assessments, as mentioned in the last section. Nonverbal attentiveness scenarios given below.	
Note Taking	
The teacher is leading instruction and a student does not verbally participate but is taking detailed notes on a piece of paper (yes if notes on topic, which would require close monitoring).	1
A student has his or her computer out and is very focused on it as he or she takes notes on the material (yes if notes on topic, which would require close monitoring).	0
Note: As the appearance of note taking alone cannot guarantee engagement (a student could actually be writing or typing something unrelated to the material), an instructor must be able to verify that a student was engaged with the use of formative assessments	
Eye contact	
A student makes eye contact either with the instructor or with the student talking and is paying attention, and proves it by being able to solve the given problem even though he or she did not verbally participate	20
Head nods	
A teacher or classmate proposes a question or asks for verification on a step, Student A nods his or her head in agreement along with the rest of the class, and is able to solve a problem related to the question	3
Student A misses a problem on an opener. A teacher or classmate proposes a question or asks for verification on a step related to that opener problem; Student A nods his or her head in agreement along with the rest of the class. Later, Student A is able to solve a problem related to the question (showing growth)	0
Nonverbal Engagement Total:	23

Indicator	Student Engagement
Differentiation	
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can provide support to students who have shown they have some sort of misconception regarding that day's topic.	0
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a homogenous group in which he or she can work with his or her peers to work toward surpassing the goal via a challenge problem.	0
Student B shows that he or she has possible misconceptions regarding a topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can receive support from his or her peers.	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher presents Student B with a leading question to him or her better understand the problem or material. Student B is then able to enter the task and work on the problem.	0
Student A is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she has already completed the problems for the day. The teacher gives Student A a challenge problem to work on. Student A works on the problem the rest of class and may or may or not be able to solve it. (If not participating in class discussion, but working on assigned problems, still engaged.)	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to enter the task, works on the problem for the rest of class and may or may not be able to solve it and may or may not have any other interactions with the class.	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to solve the problem and move onto a problem at the next level **(yes, Student B showed growth)**	0
Differentiation Engagement Total:	9
Engagement Indicator Checklist Score:	**31**

Figure 15: Direct instruction turned lecture summary

Indicator	Direct instruction turned lecture
Teacher-Led Questions Engagement Total:	4
Student-Led Questions Engagement Total:	2
Work on the Board Engagement Total:	0
Group Work Engagement Total:	0
Student Growth → Engagement Total:	2
Nonverbal Engagement Total:	23
Differentiation Engagement Total:	0
Engagement Indicator Checklist Score:	**31**

Figure 16: A continuous look at one group

Indicator	Student Engagement
Teacher-Led Questions	
Teacher asks question, student answers	0
Teacher asks question, students reply individually on whiteboards after an adequate wait time - whiteboards are shown at the same time	0
Teacher asks question, students are to discuss their responses among themselves (yes if on-topic discussion, which would require close monitoring).	0
Teacher-Led Questions Engagement Total:	0
Student-Led Questions	
Student A asks teacher a question related to the topic	4
Student B asks either the teacher or Student A a follow up question	1
Student B responds to Student A's question	3
Student B then turns to Student C and shows he/she learned from Student A (yes twice)	1
Student asks a question to the whole class, teacher prompt students to discuss the issue in their groups (yes when on topic, which would require close monitoring).	0
A group asks the teacher a question, teacher responds by presenting a follow-up question. The group then discusses their ideas, and everyone participates.	0
Student A asks Student B a question, Student B discusses the possible answer with Student A	6
Student A asks Student B a question; Student B discusses the possible answer with Student A. Student A shows he/she understood/learned from Student B.	3
Student-Led Questions Engagement Total:	18

Figure 16 continued

Indicator	Student Engagement
Student Shows Work on the Board	
Student writes on the board (one student engaged)	0
Student writes on the board and a classmate catches and explains a mistake or provides alternate method (2 students engaged)	0
Student writes on the board and classmate asks a question (2 students engaged)	0
Student writes on the board and the class follows along, showing their work on their whiteboards. One student does not show work but is able to explain the process in his or her group or to the teacher	0
Student writes on the board and the class follows along, showing their work on their whiteboards. Then they get in groups and defend their answer/method	0
Work on the Board Engagement Total:	0
Work in Groups	
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C zones out (A and B engaged, C is not)	4
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C asks a question about the process	1
Students A and B work together to solve a problem, Student C takes notes or writes the problem out	32
Students A, B, and C work independently to solve a problem then come together to discuss their answers and/or different methods of solving, all participate in discussion	0
Students A and B work together to solve the problem, Student C listens along and then introduces a new idea that is discussed among the group	0
Students A and B discuss the problem, Student C listens and pays attention but does not contribute, but is later able to solve a similar problem on his or her own	15
Group Work Engagement Total:	52

Figure 16 continued

Indicator	Student Engagement
Formative Assessment - used to verify engagement	
Teacher gives an opener then presents a block of instruction. Student may or may not show outward signs of behavioral engagement. Teacher then presents a formative assessment and the student shows growth.	0
Student Growth → Engagement Total:	0
Nonverbal Attentiveness	
Proposal: nonverbal attentiveness can be verified as engagement with the use of formative assessments, as mentioned in the last section. Nonverbal attentiveness scenarios given below.	
Note Taking	
The teacher is leading instruction and a student does not verbally participate but is taking detailed notes on a piece of paper (yes if notes on topic, which would require close monitoring).	9
A student has his or her computer out and is very focused on it as he or she takes notes on the material (yes if notes on topic, which would require close monitoring).	2
Note: As the appearance of note taking alone cannot guarantee engagement (a student could actually be writing or typing something unrelated to the material), an instructor must be able to verify that a student was engaged with the use of formative assessments	
Eye contact	
A student makes eye contact either with the instructor or with the student talking and is paying attention, and proves it by being able to solve the given problem even though he or she did not verbally participate	64
Head nods	
A teacher or classmate proposes a question or asks for verification on a step, Student A nods his or her head in agreement along with the rest of the class, and is able to solve a problem related to the question	5
Student A misses a problem on an opener. A teacher or classmate proposes a question or asks for verification on a step related to that opener problem; Student A nods his or her head in agreement along with the rest of the class. Later, Student A is able to solve a problem related to the question (showing growth)	0
Nonverbal Engagement Total:	48

Indicator	Student Engagement
Differentiation	
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can provide support to students who have shown they have some sort of misconception regarding that day's topic.	1
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a homogenous group in which he or she can work with his or her peers to work toward surpassing the goal via a challenge problem.	
Student B shows that he or she has possible misconceptions regarding a topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can receive support from his or her peers.	2
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher presents Student B with a leading question to him or her better understand the problem or material. Student B is then able to enter the task and work on the problem.	
Student A is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she has already completed the problems for the day. The teacher gives Student A a challenge problem to work on. Student A works on the problem the rest of class and may or may or may not be able to solve it. (If not participating in class discussion, but working on assigned problems, still engaged.)	6
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to enter the task, works on the problem for the rest of class and may or may not be able to solve it and may or may not have any other interactions with the class.	
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to solve the problem and move onto a problem at the next level **(yes, Student B showed growth)**	
Differentiation Engagement Total:	9
Engagement Indicator Checklist Score:	**127**

Figure 17: A continuous look at one group summary

Indicator	Group: Continuous
Teacher-Led Questions Engagement Total:	0
Student-Led Questions Engagement Total:	18
Work on the Board Engagement Total:	0
Group Work Engagement Total:	52
Student Growth → Engagement Total:	0
Nonverbal Engagement Total:	48
Differentiation Engagement Total:	9
Engagement Indicator Checklist Score:	**127**

Figure 18: A continuous look at lecture

Indicator	Student Engagement
Teacher-Led Questions	
Teacher asks question, student answers	0
Teacher asks question, students reply individually on whiteboards after an adequate wait time - whiteboards are shown at the same time	0
Teacher asks question, students are to discuss their responses among themselves (yes if on-topic discussion, which would require close monitoring).	0
Teacher-Led Questions Engagement Total:	0
Student-Led Questions	
Student A asks teacher a question related to the topic	0
Student B asks either the teacher or Student A a follow up question	0
Student B responds to Student 1's question	0
Student B then turns to Student C and shows he/she learned from Student A (yes twice)	0
Student asks a question to the whole class, teacher prompt students to discuss the issue in their groups (yes when on topic, which would require close monitoring).	0
A group asks the teacher a question, teacher responds by presenting a follow-up question. The group then discusses their ideas, and everyone participates.	0
Student A asks Student B a question, Student B discusses the possible answer with Student A	0
Student A asks Student B a question; Student B discusses the possible answer with Student A. Student A shows he/she understood/learned from Student A.	0
Student-Led Questions Engagement Total:	0

Figure 18 continued

Indicator	Student Engagement
Student Shows Work on the Board	
Student writes on the board (one student engaged)	0
Student writes on the board and a classmate catches and explains a mistake or provides alternate method (2 students engaged)	0
Student writes on the board and classmate asks a question (2 students engaged)	0
Student writes on the board and the class follows along, showing their work on their whiteboards. One student does not show work but is able to explain the process in his or her group or to the teacher	0
Student writes on the board and the class follows along, showing their work on their whiteboards. Then they get in groups and defend their answer/method	0
Work on the Board Engagement Total:	0
Work in Groups	
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C zones out (A and B engaged, C is not)	0
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C asks a question about the process	0
Students A and B work together to solve a problem, Student C takes notes or writes the problem out	0
Students A, B, and C work independently to solve a problem then come together to discuss their answers and/or different methods of solving, all participate in discussion	0
Students A and B work together to solve the problem, Student C listens along and then introduces a new idea that is discussed among the group	0
Students A and B discuss the problem, Student C listens and pays attention but does not contribute, but is later able to solve a similar problem on his or her own	0
Group Work Engagement Total:	0

Figure 18 continued

Indicator	Student Engagement
Formative Assessment - used to verify engagement	
Teacher gives an opener then presents a block of instruction. Student may or may not show outward signs of behavioral engagement. Teacher then presents a formative assessment and the student shows growth.	1
Student Growth → Engagement Total:	1
Nonverbal Attentiveness	
Proposal: nonverbal attentiveness can be verified as engagement with the use of formative assessments, as mentioned in the last section. Nonverbal attentiveness scenarios given below.	
Note Taking	
The teacher is leading instruction and a student does not verbally participate but is taking detailed notes on a piece of paper (yes if notes on topic, which would require close monitoring).	14
A student has his or her computer out and is very focused on it as he or she takes notes on the material (yes if notes on topic, which would require close monitoring).	0
Note: As the appearance of note taking alone cannot guarantee engagement (a student could actually be writing or typing something unrelated to the material), an instructor must be able to verify that a student was engaged with the use of formative assessments	
Eye contact	
A student makes eye contact either with the instructor or with the student talking and is paying attention, and proves it by being able to solve the given problem even though he or she did not verbally participate	61
Head nods	
A teacher or classmate proposes a question or asks for verification on a step, Student A nods his or her head in agreement along with the rest of the class, and is able to solve a problem related to the question	0
Student A misses a problem on an opener. A teacher or classmate proposes a question or asks for verification on a step related to that opener problem; Student A nods his or her head in agreement along with the rest of the class. Later, Student A is able to solve a problem related to the question (showing growth)	0
Nonverbal Engagement Total:	75

Figure 18 continued

Indicator	Student Engagement
Differentiation	
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can provide support to students who have shown they have some sort of misconception regarding that day's topic.	0
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a homogenous group in which he or she can work with his or her peers to work toward surpassing the goal via a challenge problem.	0
Student B shows that he or she has possible misconceptions regarding a topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can receive support from his or her peers.	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher presents Student B with a leading question to him or her better understand the problem or material. Student B is then able to enter the task and work on the problem.	0
Student A is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she has already completed the problems for the day. The teacher gives Student A a challenge problem to work on. Student A works on the problem the rest of class and may or may or not be able to solve it. (If not participating in class discussion, but working on assigned problems, still engaged.)	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to enter the task, works on the problem for the rest of class and may or may not be able to solve it and may or may not have any other interactions with the class.	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to solve the problem and move onto a problem at the next level **(yes, Student B showed growth)**	0
Differentiation Engagement Total:	0
Engagement Indicator Checklist Score:	76

Figure 19: A continuous look at lecture summary

Indicator	Lecture: Continuous
Teacher-Led Questions Engagement Total:	0
Student-Led Questions Engagement Total:	0
Work on the Board Engagement Total:	0
Group Work Engagement Total:	0
Student Growth → Engagement Total:	1
Nonverbal Engagement Total:	75
Differentiation Engagement Total:	0
Engagement Indicator Checklist Score:	**76**

Figure 20: A continuous look at direct instruction

Indicator	Student Engagement
Teacher-Led Questions	
Teacher asks question, student answers	4
Teacher asks question, students reply individually on whiteboards after an adequate wait time - whiteboards are shown at the same time	0
Teacher asks question, students are to discuss their responses among themselves (yes if on-topic discussion, which would require close monitoring).	0
Teacher-Led Questions Engagement Total:	4
Student-Led Questions	
Student A asks teacher a question related to the topic	0
Student B asks either the teacher or Student A a follow up question	2
Student B responds to Student 1's question	2
Student B then turns to Student C and shows he/she learned from Student A (yes twice)	2
Student asks a question to the whole class, teacher prompt students to discuss the issue in their groups (yes when on topic, which would require close monitoring).	0
A group asks the teacher a question, teacher responds by presenting a follow-up question. The group then discusses their ideas, and everyone participates.	0
Student A asks Student B a question, Student B discusses the possible answer with Student A	3
Student A asks Student B a question; Student B discusses the possible answer with Student A. Student A shows he/she understood/learned from Student A.	0
Student-Led Questions Engagement Total:	9

Figure 20 continued

Indicator	Student Engagement
Student Shows Work on the Board	
Student writes on the board (one student engaged)	0
Student writes on the board and a classmate catches and explains a mistake or provides alternate method (2 students engaged)	0
Student writes on the board and classmate asks a question (2 students engaged)	0
Student writes on the board and the class follows along, showing their work on their whiteboards. One student does not show work but is able to explain the process in his or her group or to the teacher	0
Student writes on the board and the class follows along, showing their work on their whiteboards. Then they get in groups and defend their answer/method	0
Work on the Board Engagement Total:	0
Work in Groups	
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C zones out (A and B engaged, C is not)	0
Student A solves problem in a group, Student B in the group finds a mistake and explains it, Student C asks a question about the process	0
Students A and B work together to solve a problem, Student C takes notes or writes the problem out	0
Students A, B, and C work independently to solve a problem then come together to discuss their answers and/or different methods of solving, all participate in discussion	0
Students A and B work together to solve the problem, Student C listens along and then introduces a new idea that is discussed among the group	0
Students A and B discuss the problem, Student C listens and pays attention but does not contribute, but is later able to solve a similar problem on his or her own	0
Group Work Engagement Total:	0

Figure 20 continued

Indicator	Student Engagement
Formative Assessment - used to verify engagement	
Teacher gives an opener then presents a block of instruction. Student may or may not show outward signs of behavioral engagement. Teacher then presents a formative assessment and the student shows growth.	2
Student Growth → Engagement Total:	2
Nonverbal Attentiveness	
Proposal: nonverbal attentiveness can be verified as engagement with the use of formative assessments, as mentioned in the last section. Nonverbal attentiveness scenarios given below.	
Note Taking	
The teacher is leading instruction and a student does not verbally participate but is taking detailed notes on a piece of paper (yes if notes on topic, which would require close monitoring).	24
A student has his or her computer out and is very focused on it as he or she takes notes on the material (yes if notes on topic, which would require close monitoring).	0
Note: As the appearance of note taking alone cannot guarantee engagement (a student could actually be writing or typing something unrelated to the material), an instructor must be able to verify that a student was engaged with the use of formative assessments	
Eye contact	
A student makes eye contact either with the instructor or with the student talking and is paying attention, and proves it by being able to solve the given problem even though he or she did not verbally participate	55
Head nods	
A teacher or classmate proposes a question or asks for verification on a step, Student A nods his or her head in agreement along with the rest of the class, and is able to solve a problem related to the question	0
Student A misses a problem on an opener. A teacher or classmate proposes a question or asks for verification on a step related to that opener problem; Student A nods his or her head in agreement along with the rest of the class. Later, Student A is able to solve a problem related to the question (showing growth)	0
Nonverbal Engagement Total:	79

Indicator	Student Engagement
Differentiation	
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can provide support to students who have shown they have some sort of misconception regarding that day's topic.	0
Student A shows that he or she has meet the goal regarding that day's topic based on the pre-assessments results. The instructor then places that student in a homogenous group in which he or she can work with his or her peers to work toward surpassing the goal via a challenge problem.	0
Student B shows that he or she has possible misconceptions regarding a topic based on the pre-assessments results. The instructor then places that student in a heterogeneous group in which he or she can receive support from his or her peers.	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher presents Student B with a leading question to him or her better understand the problem or material. Student B is then able to enter the task and work on the problem.	0
Student A is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she has already completed the problems for the day. The teacher gives Student A a challenge problem to work on. Student A works on the problem the rest of class and may or may or may not be able to solve it. (If not participating in class discussion, but working on assigned problems, still engaged.)	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to enter the task, works on the problem for the rest of class and may or may not be able to solve it and may or may not have any other interactions with the class.	0
Student B is found not interacting with a teacher-planned activity or problem. The teacher sees that he or she is frustrated with the difficulty of the problem and is unable to enter the task. The teacher gives Student B a problem more suited for his or her ability in this case. Student B is able to solve the problem and move onto a problem at the next level **(yes, Student B showed growth)**	0
Differentiation Engagement Total:	0
Engagement Indicator Checklist Score:	**94**

Figure 21: A continuous look at direct instruction summary

Indicator	Direct Instruction: Continuous
Teacher-Led Questions Engagement Total:	4
Student-Led Questions Engagement Total:	9
Work on the Board Engagement Total:	0
Group Work Engagement Total:	0
Student Growth → Engagement Total:	2
Nonverbal Engagement Total:	79
Differentiation Engagement Total:	0
Engagement Indicator Checklist Score:	**94**

Figure 22: Original whole-class

Results of a contingency table X^2 statistical test

Data: contingency table

	A	B	C	
1	2	1	15	18
2	7	16	10	33
3	1	0	0	1
4	0	22	0	22
5	11	1	16	28
6	29	4	23	56
7	0	40	0	40
	50	84	64	198

Expected: contingency table

	A	B	C
1	4.55	7.64	5.82
2	8.33	14.0	10.7
3	0.253	0.424	0.323
4	5.56	9.33	7.11
5	7.07	11.9	9.05
6	14.1	23.8	18.1
7	10.1	17.0	12.9

Chi-square = 160

Degrees of freedom = 12

Probability = 0.000

Figure 23: Continuous record

Results of a contingency table X^2 statistical test

Data: contingency table

	A	B	C	
1	0	0	4	4
2	0	18	9	27
3	1	0	0	1
4	0	52	0	52
5	1	0	2	3
6	75	48	79	202
7	0	9	0	9
	77	127	94	298

Expected: contingency table

	A	B	C
1	1.03	1.70	1.26
2	6.98	11.5	8.52
3	0.258	0.426	0.315
4	13.4	22.2	16.4
5	0.775	1.28	0.946
6	52.2	86.1	63.7
7	2.33	3.84	2.84

Chi-square = 137

Degrees of freedom = 12

Probability = 0.000